



U.S. Army Armament Research, Development and Engineering Center



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## THE SQUAD PERFORMANCE TEST BED

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14. ABSTRACT <b>ARDEC, the parent organization of the Target Behavioral Response Laboratory seeks to provide devices to improve Squad lethality, survivability, and mobility, in order to improve Squad-level function. It is well recognized that these three functions can be mutually exclusive in that devices that increase lethality may also decrease survivability (alternatively situational awareness) or decrease mobility. However, there exists no method to conduct critical trade-off analyses of candidate solutions to optimize Squad level performance. The Squad Performance Test Bed consists of both an outdoor and indoor test bed. The outdoor Squad Performance Test Bed consists of a large geographic area that will be instrumented to capture behaviors of collectives (Fire Teams, Squads, Platoons, etc) during outdoor Warfighter Battle Drills. The outdoor SPTB is approximately 700 x 500 meters, over hilly, grassy, and wooded terrain, including roads and a helipad. The outdoor test bed is configured for future data capture during the Battle Drill scenario React to Contact. In this scenario, the Squad receives enemy fire and must react (e.g., seek cover and return fire). The indoor SPTB is configured to simulate the environment appropriate to Close Quarters Battle (CQB) consisting of several rooms in order to conduct testing of the room entry and clearing scenarios. A reconfigurable room was built in order to conduct the task, Room Entry and Clearing. In this scenario, the Squad must come from outside the building, enter a room, shoot enemy found in the room, spare others, and move through other rooms in the same way, without being killed. At this point in time, both the outdoor and indoor Squad Performance Test Beds have undergone preliminary building and testing, under the supervision of Subject Matter Experts in Soldier training. When completed and tested, the Squad Performance Test Bed will give ARDEC and others a unique capability for testing and evaluating materiel and personnel solutions in order to enhance Squad lethality, survivability, and mobility.</b>		

## 15. SUBJECT TERMS

**Squad, Human Test Facility, Indoor Test bed, Outdoor Test bed, Testing and Evaluation, Soldier Performance, Motion Capture, Behavioral Coding, Close Quarters Combat, React to Contact**

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- **Introduction**
  - ARDEC
  - Performance Evaluation at TBRL
- **The SQUAD Performance Test Bed**
  - Environment
  - Instrumentation
- **Measuring Performance**
  - Behavior Coding Process
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  - Behavior Analysis
- **Summary**
- **Conclusions**

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# ARDEC's Role



RESEARCH



DEVELOPMENT



PRODUCTION



FIELD SUPPORT



DEMILITARIZATION

## Advanced Weapons:

Line of sight/beyond line of sight fire; non line of sight fire; scalable effects; non-lethal; directed energy; autonomous weapons

## Ammunition:

Small, medium, large caliber; propellants; explosives; pyrotechnics; warheads; insensitive munitions; logistics; packaging; fuzes; environmental technologies and explosive ordnance disposal

## Fire Control:

Battlefield digitization; embedded system software; aero ballistics and telemetry

*ARDEC provides the technology for over 90% of the Army's lethality and a significant amount of support for other services' lethality*

## *Military Need for Squad Performance Evaluation*

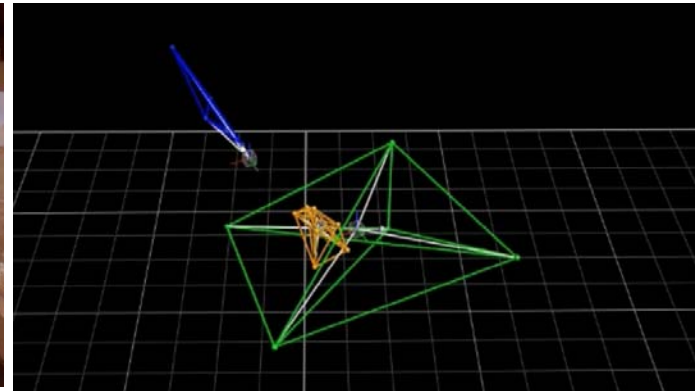
- ARDEC seeks to improve Soldier/Squad; lethality, survivability, and mobility
- Trade-off analysis are necessary to produce the most effective Soldier
- Group-level metrics are desired to measure squad performance
- Materiel evaluation will help to achieve optimum squad performance



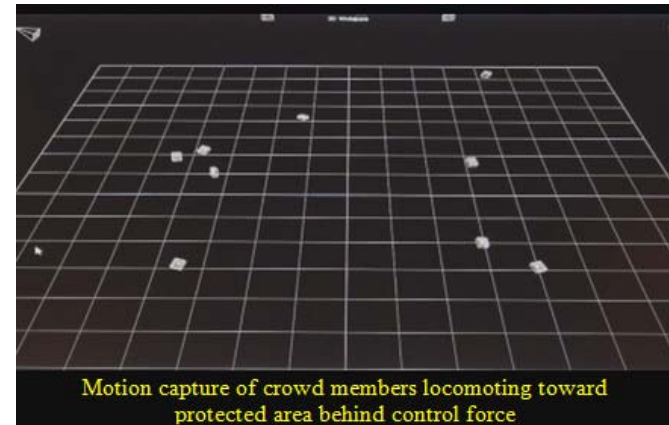


# Introduction

## *Performance Evaluation at TBRL*



- Performance of individual Soldiers using ARDEC systems



- Performance of Non-Lethal Weapons against targets



# The Squad Performance Test Bed

## *Goals for Squad Performance Test Bed (SPTB)*

- Operationally relevant metrics for squad and individual Soldiers
  - Measures of Effectiveness (MoE)
  - Measures of Performance (MoP)
- Incorporate metrics and measures into modeling and simulation
- Human factors that impact candidate materiel solutions
- Squad-level behavioral response to candidate materiel
- Paradigm to test, record, and assess effects of psychosocial variables in personnel
  - Situational Awareness
  - Leadership
  - Training
  - Cohesiveness

# The Squad Performance Test Bed

## Outdoor SPTB - Environment

- 700 x 500 meters over hilly, grassy, and wooded terrain
- Configured for React to Contact Battle Drill scenario
- Instrumented to capture behaviors of collective teams
- Location tracking
- Battlefield effects simulation

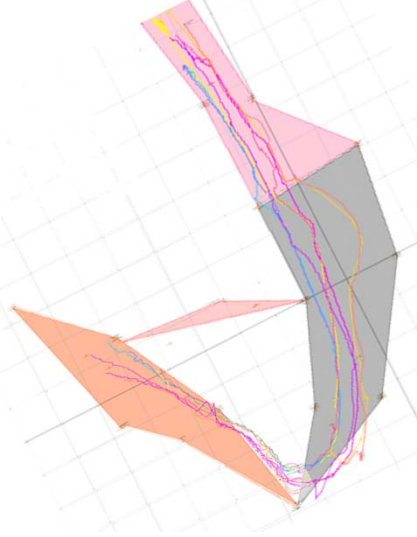


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# The Squad Performance Test Bed

## *Outdoor SPTB - Instrumentation*

- **Location Tracking System**
  - Ubisense Real-Time Location Tracking System (RTLS)
    - Ubisense Series 7000 sensors & tags
    - Tags worn by team members as the maneuver test bed
    - Computer system
      - Displays & 2-D or 3-D graphs of Soldiers path as traveled
      - Records X,Y,Z coordinates of each Soldier



# The Squad Performance Test Bed

## *Outdoor SPTB - Instrumentation*

- **Video recording systems**
  - IP cameras & computer system
    - Display & record Soldiers within the test bed
  - Personal worn cameras
    - Record communicable behaviors & first person perspective
- **Battlefield effect simulation**
  - Machine-gun enemy fire simulated using pyrotechnics
    - COPAS Micro Pyro System
      - Controller Unit, Launcher, and Pyrotechnic rounds

# The Squad Performance Test Bed

## *Outdoor SPTB - Instrumentation*

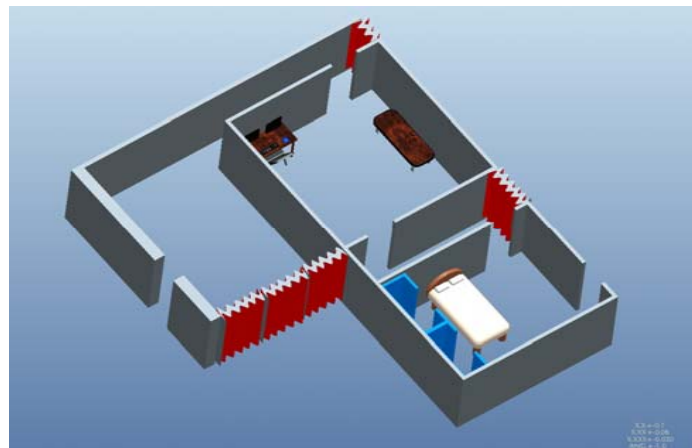
- **Weapon system & rounds simulation**
  - Real weight replicas of squad hand-carried weapons
  - Airsoft Automatic Electric Guns (AEG)
- **LabVIEW software**
  - Triggering & recording events
    - Synchronize target presentation
    - Synchronize battlefield effects
    - Shooter performance



# The Squad Performance Test Bed

## *Indoor SPTB - Environment*

- Flash-bang range, two rooms and a courtyard for room entry scenarios
- Simulate Close Quarters Battle (CQB)
- Modular room to test right, left, and center fed rooms
- Motion capture technology

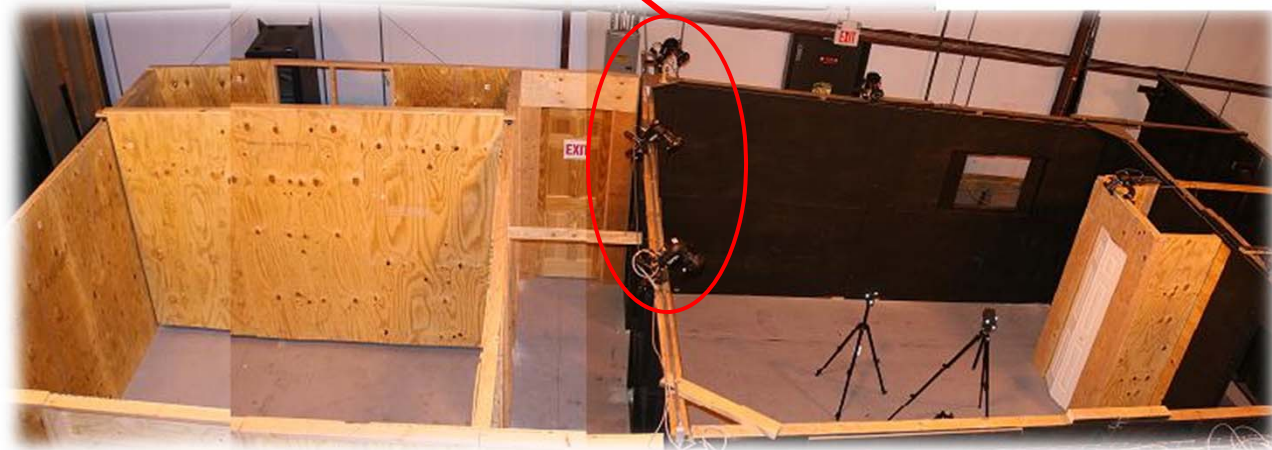
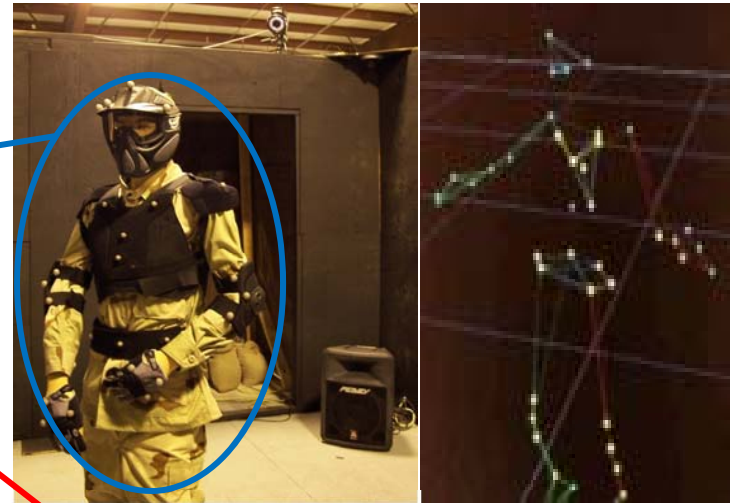




# The Squad Performance Test Bed

## *Indoor SPTB - Instrumentation*

- **Motion capture system**
  - Uniquely configured Retro-reflective markers
  - Vicon MoCap cameras
  - Computer system that displays and records Soldier location data with 6 degree of freedom



# The Squad Performance Test Bed

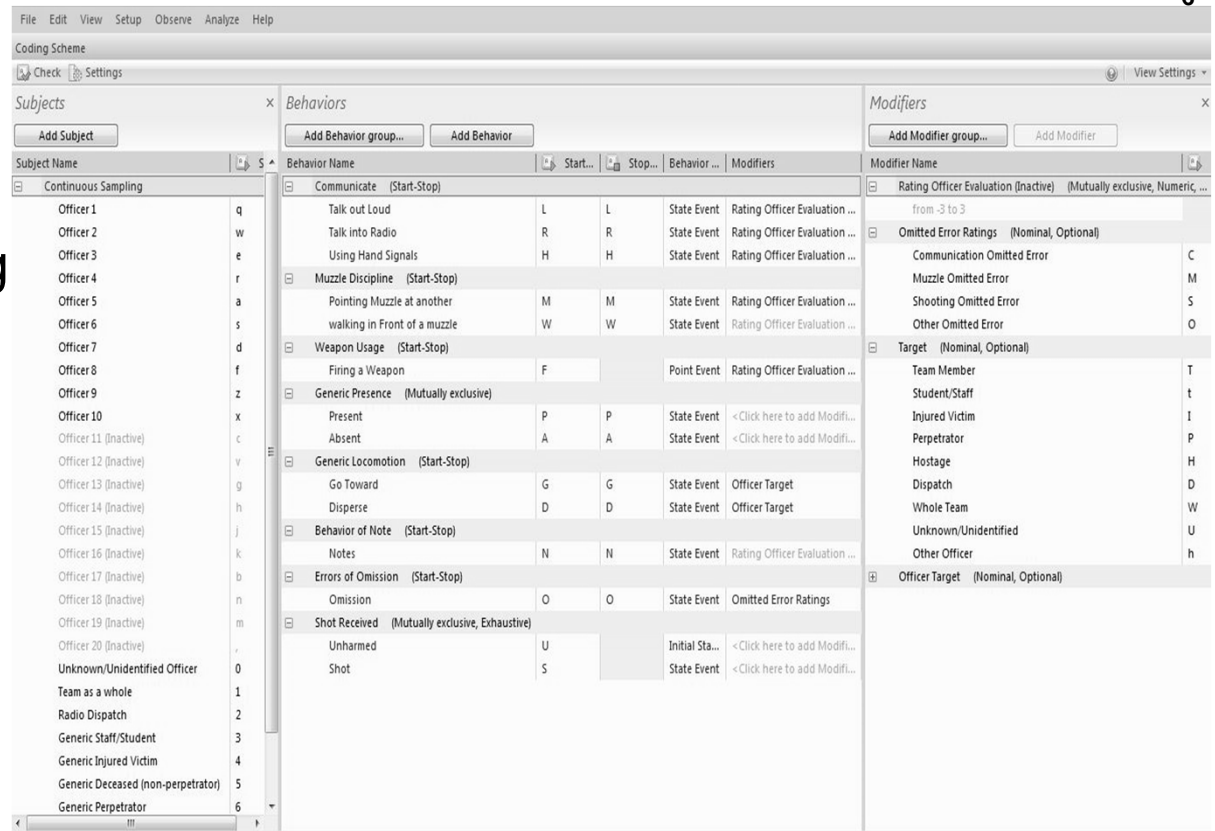
## *Indoor SPTB - Instrumentation*

- **Video recording systems**
  - IP camera system
  - Personal worn cameras
- **Weapon system & rounds simulation**
  - Airsoft AEG weapons
- **LabVIEW software**
  - Triggering & recording events
    - Synchronized target presentation
    - Shooter performance



## Behavior Coding Process - Codebook

- Capturing behaviors of interest
  - Noldus Observer XT 11.5 behavior coding
    - Behavior codebook
    - Import multi-camera views
    - Code behaviors of interest
    - Perform analysis



# Measuring Performance

## ***SPTB – Behavior Codebook***

- **Deriving behaviors of interest**
  - Gain understanding of most relevant behaviors
    - Interviews with Soldier trainers
    - Examining training doctrine of battle drills
    - Group list of behaviors in categories
    - Subject matter expert confirmation

# Measuring Performance

## ***SPTB – Behavioral Coding***

- **Example behaviors of interest**
  - Response to simulated attack of enemy forces
    - Locomotive behaviors
      - Formation during cover & advancement
      - Distance between Soldiers
    - Communicable behaviors
    - Use of force
  - Room entry & clearing
    - Locomotive behaviors
      - Movement to designated area of rooms
      - Movement in side and center fed doorways
    - Communicable behaviors
    - Interaction with hostile and non-hostile targets
    - Use of force



# Measuring Performance

## Behavior Coding Process – Video Synchronization

The Observer XT 11 - WOAS\_2013\_FullCodeBook\_Team1

File Edit View Setup Observe Analyze Help

F\_Team1\_Library - Event log

Videos

Team 1\_Library C06\_GPO10050.mp4

Team 1\_Library C07\_GPO10016.mp4

Time	Subject	Behavior	Modifier	Comment
0.00	Start			
0.00	Generic Perpetrator	Unharmd		
0.00	Generic Perpetrator	Present		
0.00	Generic Deceased (n	Present		2 deceased present
0.00	Officer 1	Unharmd		
0.00	Officer 2	Unharmd		
0.00	Officer 3	Unharmd		
0.00	Officer 4	Unharmd		
19.42	Officer 1	Talk out Loud	Whole Team	Go Go Go
20.56	Officer 1	Talk out Loud	Whole Team	

Playback Control

Not Recording

9.04

Codes

Subjects	Behaviors	Modifiers	Status
Officer 1			Unharmd
Officer 2			Unharmd
Officer 3			Unharmd
Officer 4			Unharmd
Unknown/Unid...			
Generic Staff/St...			
Generic Injured			

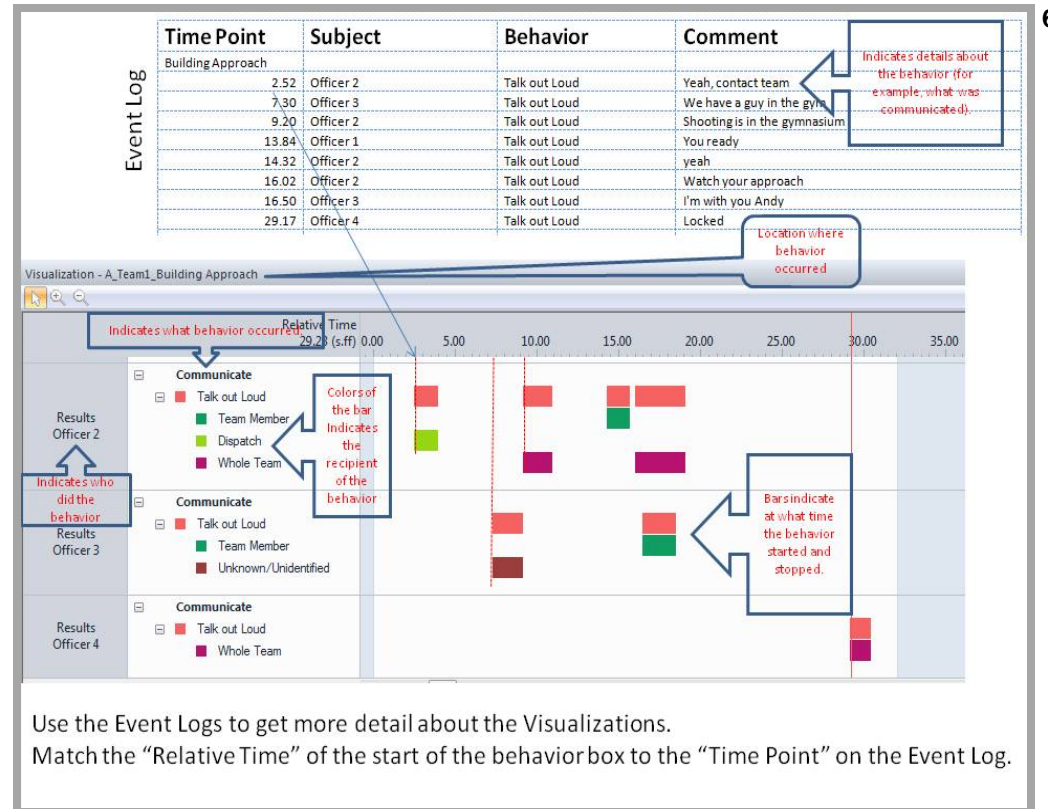
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# Measuring Performance

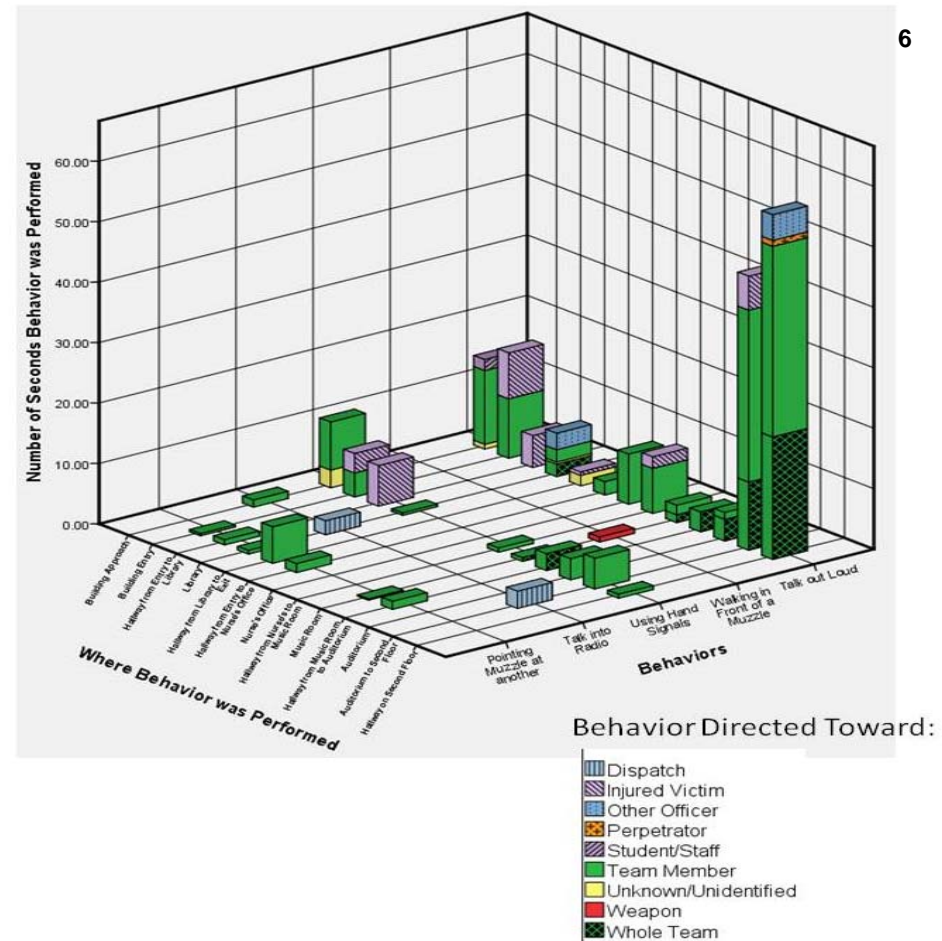
## Behavior Coding Process – Event Log

- Recording behaviors of interest
  - Event Log tracks all coded behavior on a timeline table
  - Visualization graph displays behavior coded per category



## Behavioral Analysis Example

- **Analyzing behaviors of interest**
  - Team analysis focusing on Communication, Muzzle Discipline and Weapon Usage
  - Produce timeline visualization of behaviors
  - Descriptive statistics with plots or results
  - Export data for qualitative analysis



## Summary



- Similar testing conducted with police teams show successful development and evaluation of MoP using location tracking system, video recording systems, and behavioral coding techniques
- Preliminary testing at the TBRL SPTB allowed assessment of the development and testing process which led to refinement of the test bed design plans
- Lessons learned from preliminary testing and police testing are being incorporated in the SPTB test plan
- Future plans include completion and full testing of the SPTB
- Upon completion of the SPTB, ARDEC and other groups will be able to evaluate MoP & MoE for individual Soldiers and squads

## Conclusion

- ✓ Preliminary building and testing of indoor and outdoor test bed to compare performance of Soldiers and squads
  - ✓ Determine location tracking system sensor configuration
  - ✓ Test video recording systems
  - ✓ Acquire materials and gear for soldier testing
  - ✓ Acquired safety and environmental approvals
- ✓ Evaluation of team and individual behaviors using codebook
  - ✓ Development of a behavioral codebook for battle teams
  - ✓ Behavior coding of teams and individuals
  - ✓ Behavior analysis of teams and individuals
- Test and evaluate change in performance with and without candidate materiel solutions to enhance squad lethality, survivability, and mobility

## References

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## Target Behavioral Response Laboratory MORSS Presentations



- Virtual Employment Test Bed: Operational Research and Systems Analysis to Test Armaments Designs Early in the Life Cycle
- Method and Process for the Creation of modeling and Simulation Tools for Human Crowd Behavior
- Squad Modeling and Simulation for Analysis of Materiel and Personnel Solutions
- The Squad Performance Test Bed
- Crowd Characteristics and Management with Non-Lethal Weapons: A Soldier Survey
- Effectiveness Testing and Evaluation of Non-lethal Weapons for Crowd Management
- Effects of Control Force Number, Threat, And Weapon Type on Crowd Behavior



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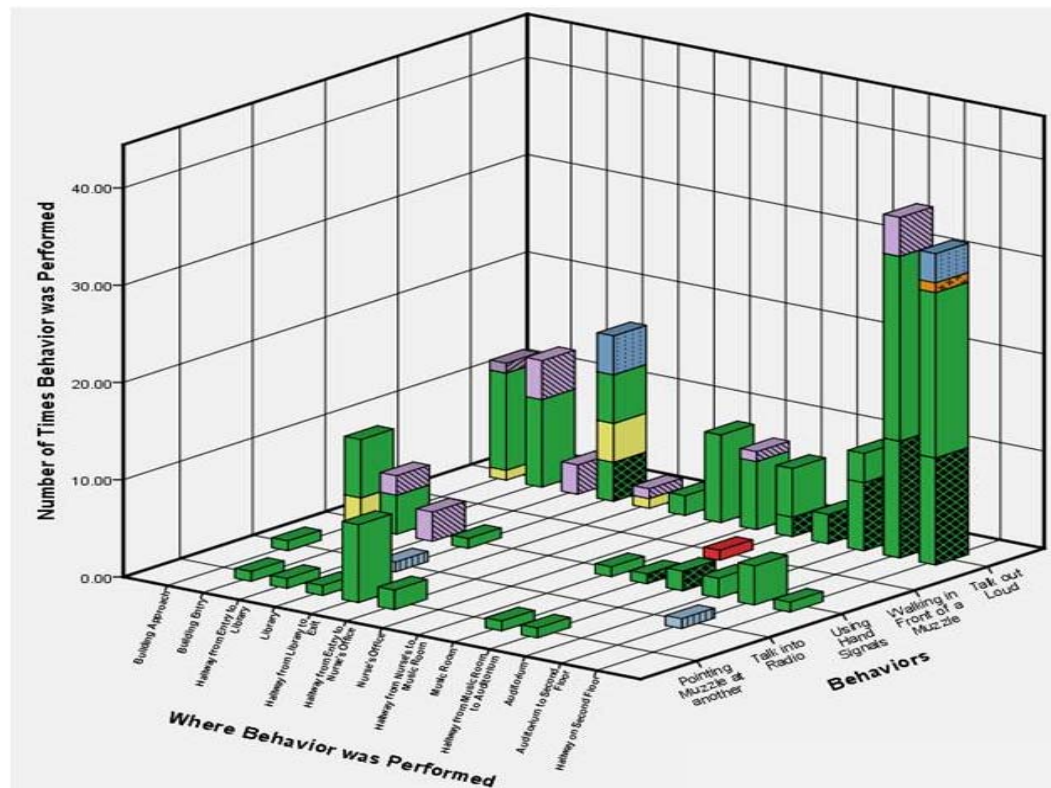
## Questions?

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# BACKUP SLIDES

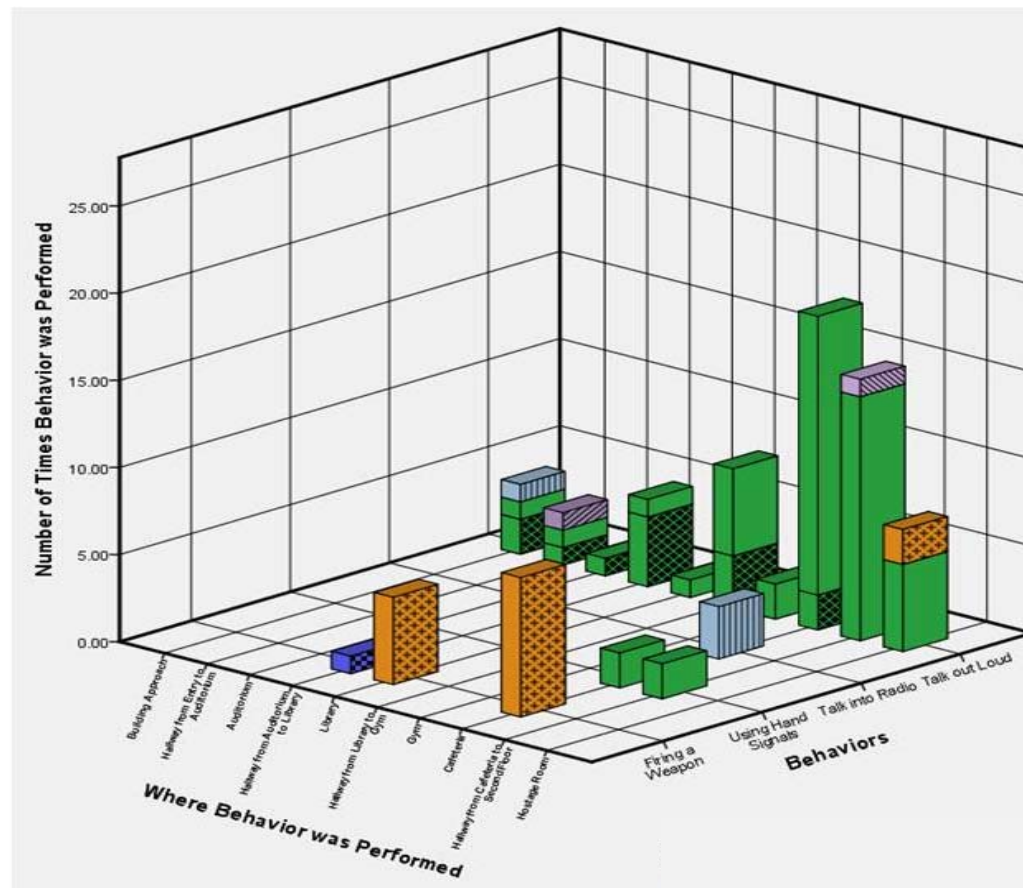
# Team Frequency Plot



Behavior Directed Toward: 6

- Dispatch
- Injured Victim
- Other Officer
- Perpetrator
- Student/Staff
- Team Member
- Unknown/Unidentified
- Weapon
- Whole Team

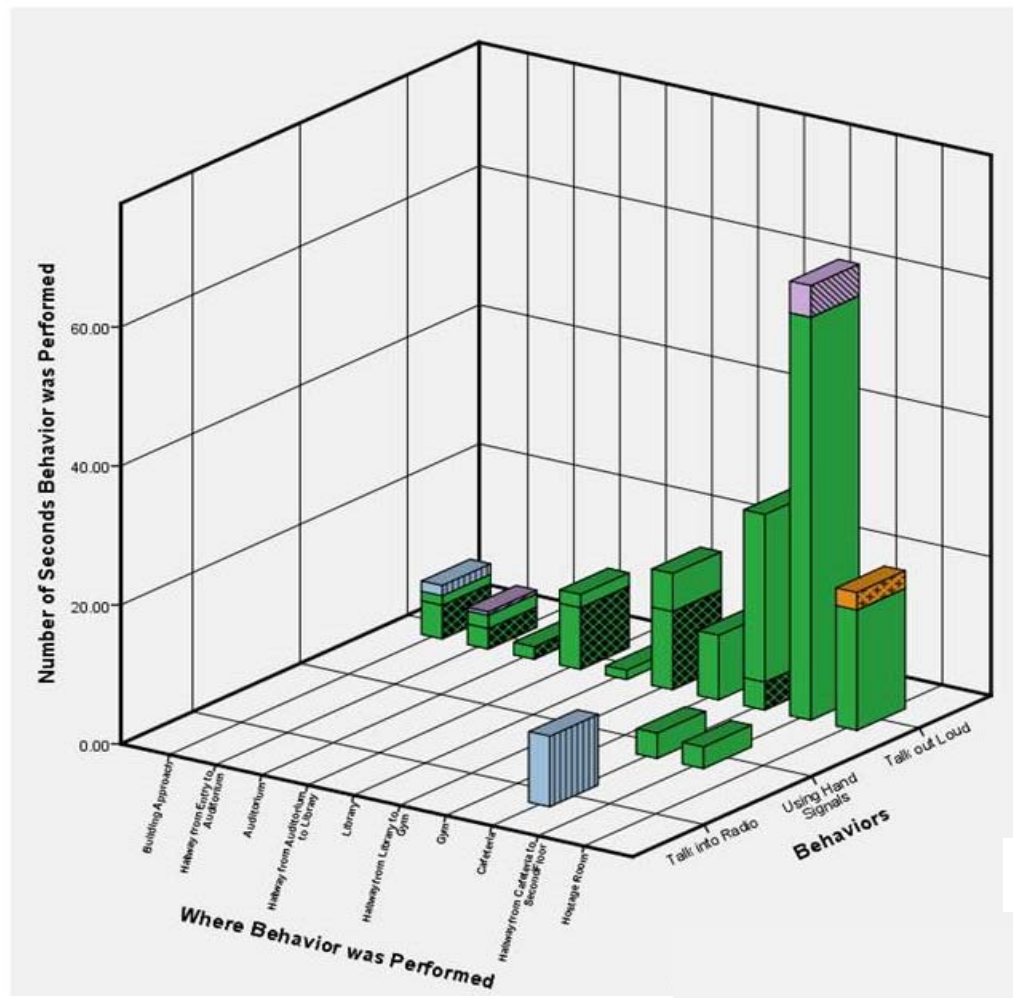
# Individual Frequency Plot



Behavior Directed Toward: 6

- Dispatch
- Injured Victim
- Other Officer
- Perpetrator
- Student/Staff
- Team Member
- Unknown/Unidentified
- Weapon
- Whole Team

# Individual Duration Plot



Behavior Directed Toward: <sup>6</sup>

- Dispatch
- Injured Victim
- Other Officer
- Perpetrator
- Student/Staff
- Team Member
- Unknown/Unidentified
- Weapon
- Whole Team

# Behavior Summary Table

Officers	Observations	Behaviors	Modifiers	Duration (s)	Count
<b>Officer 2</b>					
Officer 2	Building Approach	Talk out Loud	Dispatch	1.5	1
Officer 2	Building Approach	Talk out Loud	Team Member	1.4	1
Officer 2	Building Approach	Talk out Loud	Whole Team	4.8	2
Officer 2	Hallway from Entry to Auditorium	Talk out Loud	Student/Staff	0.5	1
Officer 2	Hallway from Entry to Auditorium	Talk out Loud	Team Member	1.9	1
Officer 2	Hallway from Entry to Auditorium	Talk out Loud	Whole Team	3.0	1
Officer 2	Auditorium	Talk out Loud	Whole Team	1.8	1
Officer 2	Hallway from Auditorium to Library	Talk out Loud	Team Member	1.9	1
Officer 2	Hallway from Auditorium to Library	Talk out Loud	Whole Team	8.9	4
Officer 2	Hallway from Auditorium to Library	Firing a Weapon	Hostage	N/A	1
Officer 2	Library	Talk out Loud	Team Member	1.3	1
Officer 2	Library	Firing a Weapon	Perpetrator	N/A	5
Officer 2	Hallway from Library to Gym	Talk out Loud	Team Member	5.5	5
Officer 2	Hallway from Library to Gym	Talk out Loud	Whole Team	11.2	3
Officer 2	Gym	Talk out Loud	Team Member	9.3	2
Officer 2	Cafeteria	Talk out Loud	Team Member	24.1	16
Officer 2	Cafeteria	Talk out Loud	Whole Team	4.0	2
Officer 2	Cafeteria	Talk into Radio	Dispatch	10.1	3
Officer 2	Cafeteria	Using Hand Signals	Team Member	3.6	2
Officer 2	Cafeteria	Firing a Weapon	Perpetrator	N/A	8
Officer 2	Hallway from Cafeteria to Second Floor	Talk out Loud	Injured Victim	4.5	1
Officer 2	Hallway from Cafeteria to Second Floor	Talk out Loud	Team Member	58.0	14
Officer 2	Hallway from Cafeteria to Second Floor	Using Hand Signals	Team Member	3.1	2
Officer 2	Hostage Room	Talk out Loud	Perpetrator	2.5	2
Officer 2	Hostage Room	Talk out Loud	Team Member	17.3	5

6